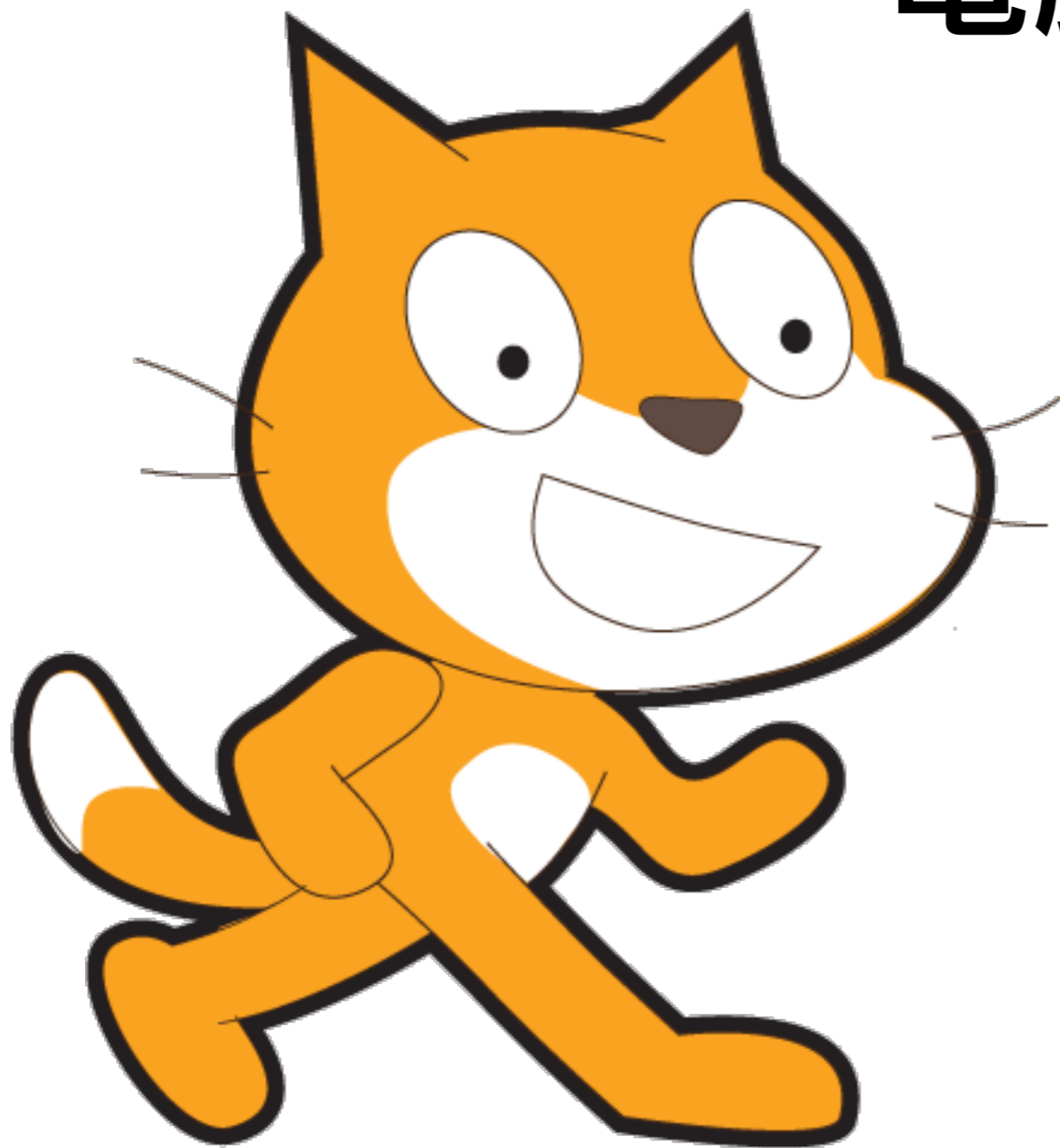


Computer Game Design

電腦遊戲設計



「刮住學」

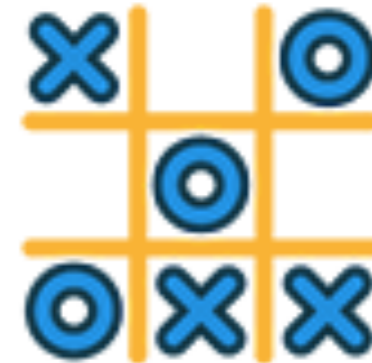
初中編程體驗比賽

“Scratch your Learning”
Programming Competition

Dr. WONG Ka Yan [Ivy]
Department of Computer Science
The University of Hong Kong

Topics to cover...

- What is a computer game?
- The genres of games
- Key components of a computer game
- Game design process
- Introduction to game programming
- Gamification



**INSERT
COINS**



What is a computer game?

What is a computer game?

- A game is a type of **play** activity, conducted in the context of a **pretended** reality, in which the participant(s) try to achieve at least one arbitrary, nontrivial **goal** by acting in accordance with **rules**.

Essential elements of a game: **Play**

- Play requires participation
- Making different choices while playing the game results in different experiences

Essential elements of a game: **Pretending**

- Creates an artificial reality known as the *magic circle*
- The magic circle separates the real world from the pretended reality
- The players assign artificial significance to the situations and events in the game, and this is an act of pretending
- To leave the magic circle, stop playing the game

Essential elements of a game: **Goal**

- Every game must have a nontrivial goal
- The rules define the goal
- The game designer sets the rules, defining the goal of the game
- The player must overcome one or more challenges to achieve the goal

Essential elements of a game: **The rules**

- Rules are definitions and instructions that players accept for the game
- Every game has rules, even if these rules are unwritten or taken for granted
- Rules define the actions the players may select that will help them achieve the goal of the game
- Game designers must make the rules understandable to the player

Gameplay

- Gameplay: the heart of game design
- Gameplay consists of:
 - ▶ The **challenges** that a player must face to arrive at the goal of the game
 - ▶ The **actions** that the player is permitted to take to address those challenges plus other possible actions that are enjoyable



The genres of games



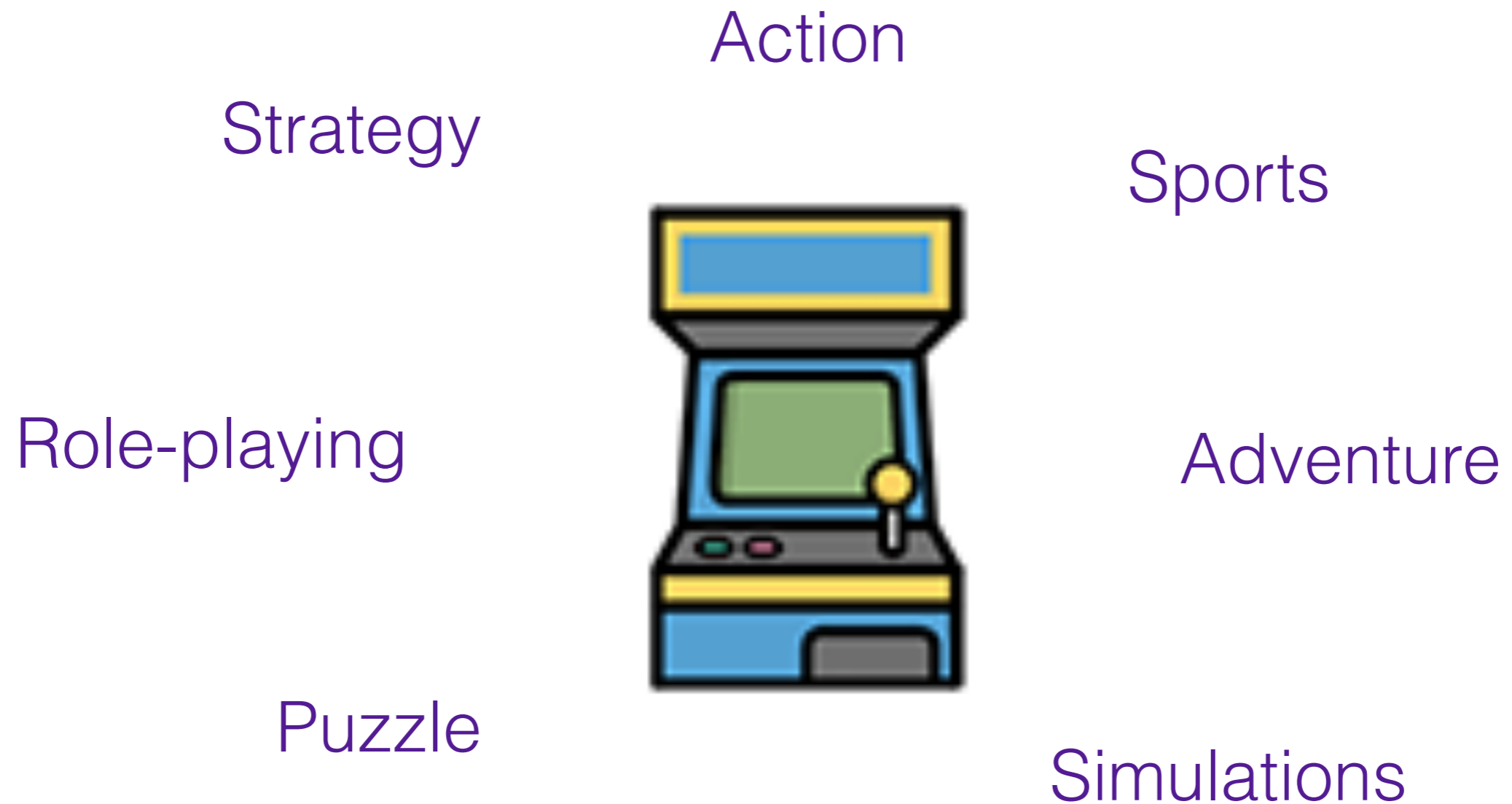
Image source:
<https://itunes.apple.com/us/app/line-disney-tsum-tsum/id867964741?mt=8>
<https://itunes.apple.com/us/app/line-cookie-run/id743669894?mt=8>
<https://itunes.apple.com/us/app/line-rangers/id767265270?mt=8>
<https://itunes.apple.com/en/app/clash-of-clans/id529479190?mt=8>

<https://itunes.apple.com/us/app/gt-racing-2-real-car-experience/id589113075?mt=8>
<https://itunes.apple.com/en/app/candy-crush-saga/id553834731?mt=8>
<https://itunes.apple.com/us/app/fifa-16-ultimate-team/id940702381?mt=8>
<https://itunes.apple.com/us/app/simcity-buildit/id913292932?mt=8>

The genres of games

- A genre is a category of games characterized by a particular set of challenges, regardless of setting or game-world content
- A game's gameplay determines its genre
- Some games cross genres

The genres of games



Action game

- An action game is one in which the majority of challenges presented are tests of the player's physical skills and coordination
- Subgenres: shooting games, platform games, and fighting games

Action game: Shooters

- In shooters, the player takes action at a distance, using a ranged weapon
- Can be a first-person shooter or third-person shooter



Space Invaders:
<http://www.pacxon4u.com/space-invaders/>



Battlefield 1943:
<https://www.battlefield.com>

Image sources:
<http://www.pacxon4u.com/space-invaders/>
https://en.wikipedia.org/wiki/File:Battlefield1943_gameplay.png

Action game: Platformers

- Platform games are cartoonish games in which an avatar moves through a vertically exaggerated environment, jumping on and off platforms of different heights, while avoiding obstacles and battling enemies



Super Mario Bros:
<http://mario.nintendo.com>

Action game: Fighting games

- Fighting games simulate hand-to-hand combat



Street Fighter:
<http://streetfighter.com/>



Little Fighter 2:
<http://lf2.net/>

Image sources:

https://en.wikipedia.org/wiki/File:Street_Fighter_EX_2.png

http://lf2.net/index_b5.html

Adventure game

- An interactive story about a protagonist character who is played by the player
- Storytelling and exploration are essential elements of the game



LEGO® Star Wars™:
The Complete Saga:
[http://www.starwars.com/games-apps/
lego-star-wars-the-complete-saga](http://www.starwars.com/games-apps/lego-star-wars-the-complete-saga)

Strategy game

- The majority of challenges are strategic conflict
- Challenge the player to achieve victory through planning and taking the optimum actions



Clash of Clans:
<https://clashofclans.com>

Role-playing game

- Player controls one or more characters, and guides them through a series of quests or story managed by the computer
- Victory consists of completing these quests
- Character grows stronger and gain more abilities during the game



Final Fantasy XIII

Sports game

- Simulates some aspect of a real or imaginary athletic sport
- Challenges and actions match the sport



FIFA 15 Ultimate Team

<http://www.ea.com/fifa15ut-mobile>

Simulation

- Simulation creates the feeling of real life
- Subgenres: vehicle simulation, construction and management simulation, life simulation

Vehicle simulation

- Creates the feeling of driving or flying a vehicle, real or imaginary
- Simulations vary from realistically representing the way the vehicle handles on the road or in the air to adding game mechanics such as combat, racing, and special challenges
- Examples: flight simulators, driving simulators

Vehicle simulation



GT Racing 2: The Real Car Exp
<http://www.gameloft.com/iphone-games/gt-racing-2-free/?adid=101966>



Microsoft Flight Simulator
<https://www.microsoft.com/Products/Games/FSInsider/product/Pages/>

Image sources:

<https://itunes.apple.com/us/app/gt-racing-2-real-car-experience/id589113075?mt=8>

https://en.wikipedia.org/wiki/File:C172_g1000_screenshot.png

Construction and management simulation

- The majority of the challenges are economic, concerned with growth
- Builds something within the context of an ongoing process
- Free-form construction, or prebuilt scenarios for the player to manage

Construction and management simulation



RollerCoaster Tycoon
<http://www.rollercoastertycoon.com>



SimCity
<http://www.simcity.com/>

Image sources:

<https://itunes.apple.com/us/app/rollercoaster-tycoon-4-mobile/id797639732?mt=8>

http://www.simcity.com/en_US/game/info/single-player

Life simulation

- Focus on maintaining and growing a manageable population of organisms



The Sims
<https://www.thesims.com>

Image source:
<https://itunes.apple.com/us/app/the-sims-freeplay/id466965151?mt=8>

Puzzle game

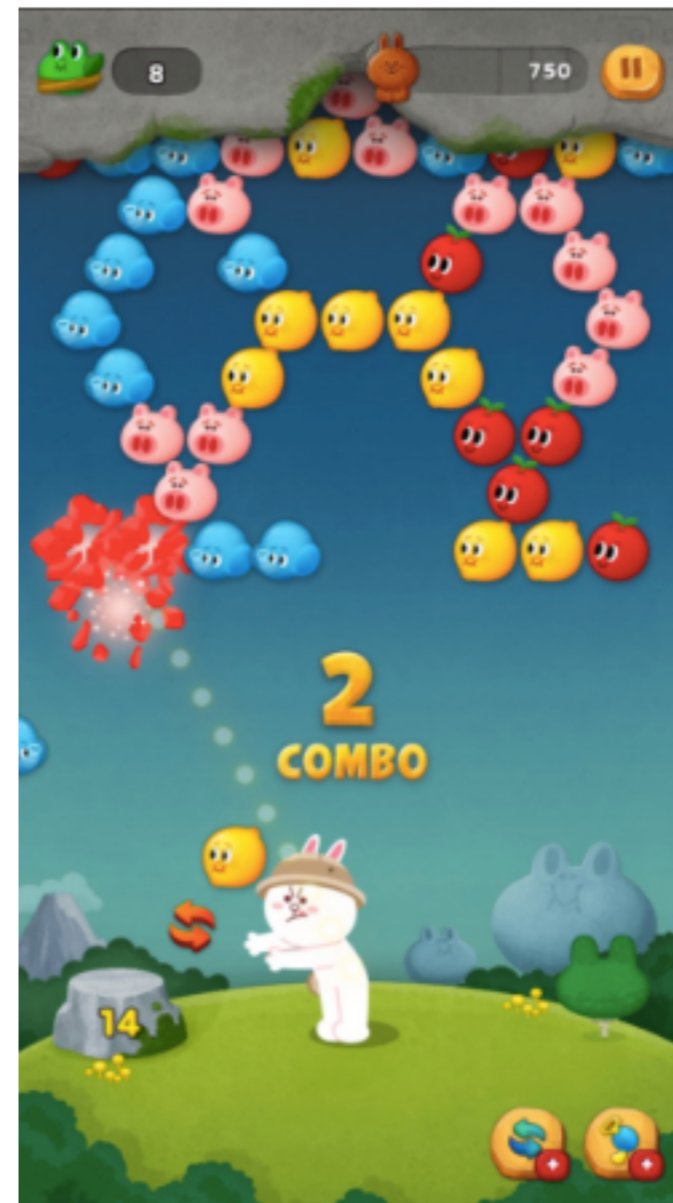
- Puzzle solving
- Types of puzzles typically include pattern recognition, logic, or understanding processes

Puzzle game



Candy Crush SAGA

<http://candycrushsaga.com/>



LINE Bubble 2

<http://linecorp.com/th/pr/news/en/2015/981>

Image sources:

<http://candycrushsaga.com/how-to-play>

<http://linecorp.com/th/pr/news/en/2015/981>

Key components of computer game

Key components of games

- Core mechanics
- User interface
- Storytelling engine (if applicable)

Core mechanics

- One of a game designer's tasks is to turn the general rules of the game into a symbolic and mathematical model that can be implemented algorithmically. This model is called the **core mechanics** of the game

More on core mechanics

- Core mechanics generate the gameplay
 - ▶ Define the challenges
 - ▶ Define the actions
 - ▶ Define the player's effect on the game world
- Core mechanics determine how realistic the game world seems to the player

User interface

- Mediates between the core mechanics and the player
 - Takes the challenges that are generated by the core mechanics and turns them into visual and audio elements
 - Turns the player's input on the hardware into actions within the game world
- Presents the game world to the player
- Includes artwork and audio effects

Relationship between core mechanics, user interface and the player

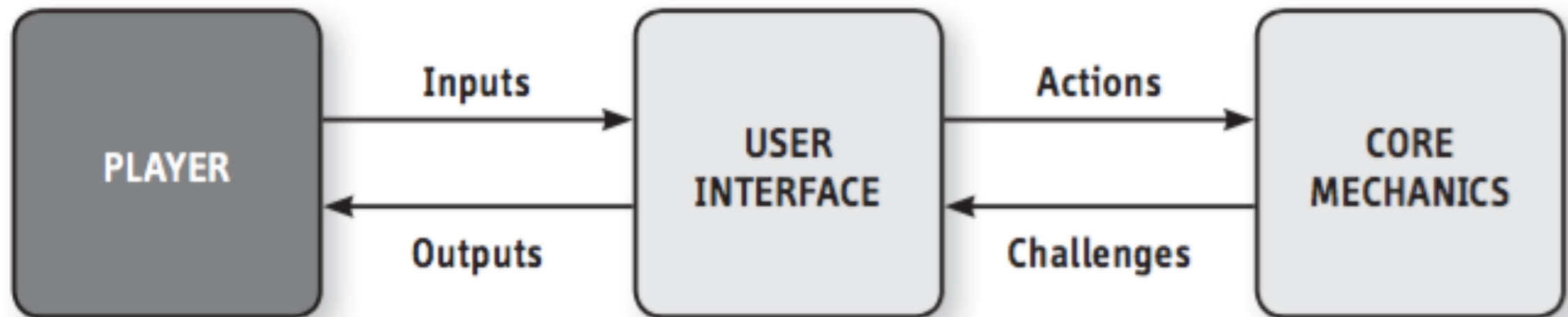


Image source: Ernest Adams, Fundamental of Game Design, 2nd edition, New riders, 2010

Essential feature of user interface

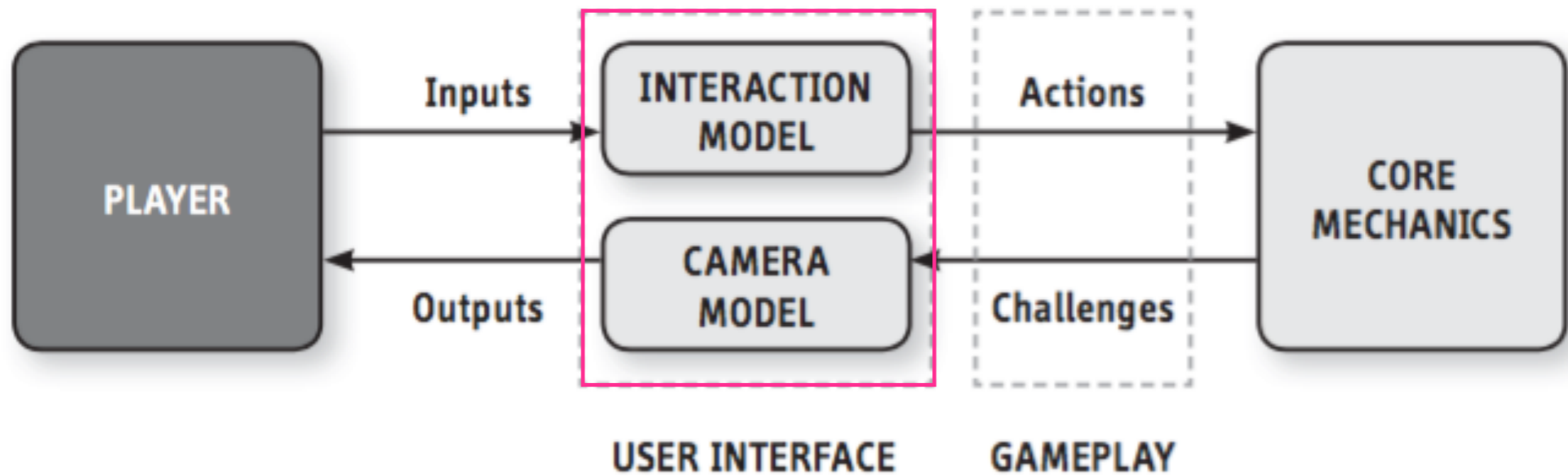


Image source: Ernest Adams, Fundamental of Game Design, 2nd edition, New riders, 2010

Interaction model

- User interface turns player's input on the hardware into actions within the game world
- The relationship between the player's inputs and the resulting actions is handled by the game's interaction model
- Identifies the way the player acts upon the game world

Camera model

- Viewpoint of the virtual camera, creating the image that the player sees
- The camera moves in response to player actions or events in the game world



Battlefield 1943:
<https://www.battlefield.com>



Little Fighter 2:
<http://lf2.net/>

Image sources:

https://en.wikipedia.org/wiki/File:Street_Fighter_EX_2.png

https://en.wikipedia.org/wiki/File:Battlefield1943_gameplay.png

Structure of game

- The structure of a computer game is composed of:
 - ▶ Gameplay modes
 - ▶ Shell menus

Gameplay mode

- A gameplay mode consists of the particular subset of a game's total gameplay that is available at any one time in the game, plus the user interface that presents that subset of the gameplay to the player

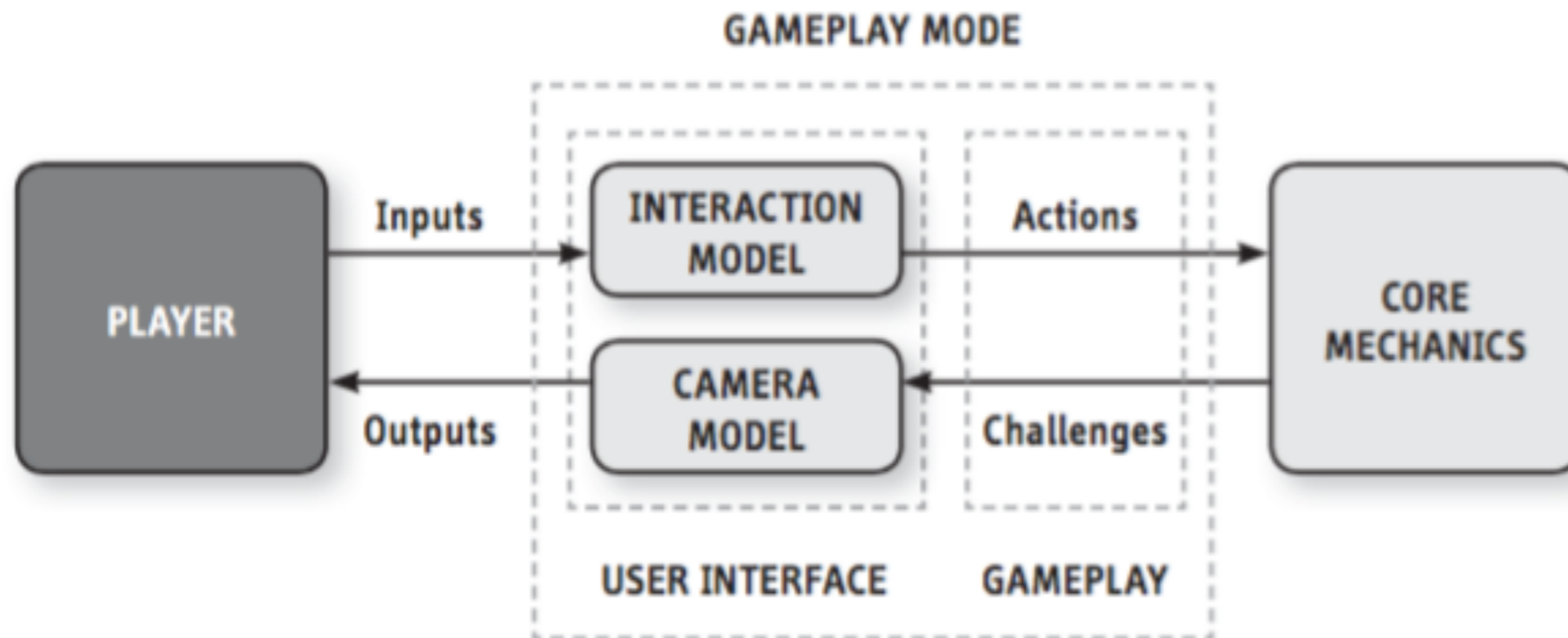


Image source: Ernest Adams, Fundamental of Game Design, 2nd edition, New riders, 2010

Gameplay modes



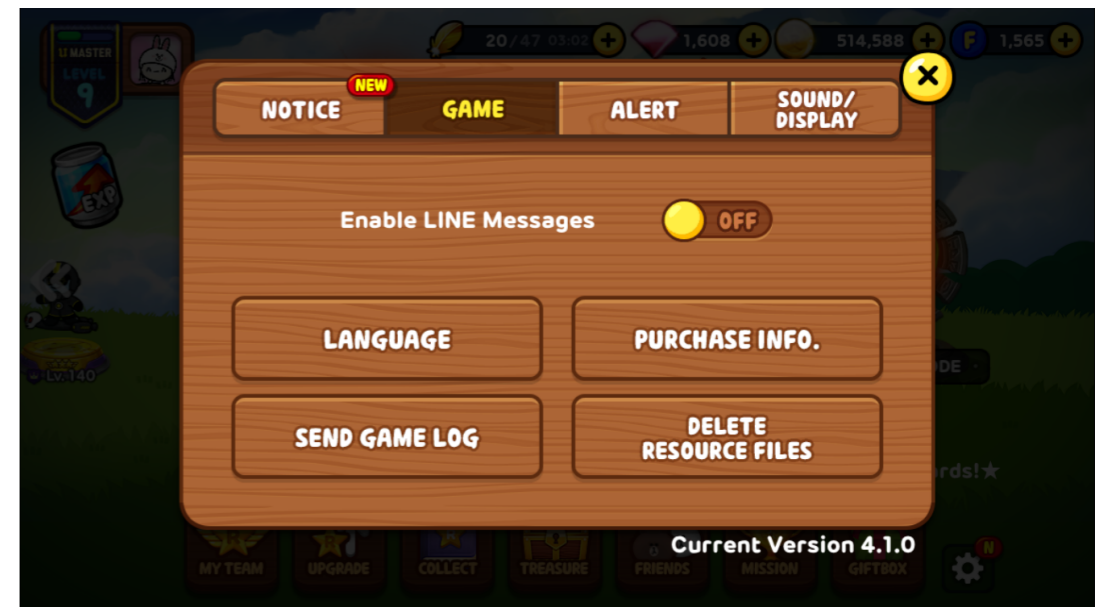
LINE Rangers: Special stage mode



LINE Rangers: Arena mode

Shell menus

- Shell menus are used when the player is not in the game modes
- Examples of activities available in a shell menu include loading and saving the game, setting the audio volume and screen resolution, and reconfiguring the input devices



LINE Rangers: Options menu

Game design process

What is game design?

- Game design is the process of
 - ▶ Imagining a game
 - ▶ Defining the way it works
 - ▶ Describing the elements that make up the game (conceptual, functional, artistic, etc)
 - ▶ Communicating the design to implementers

Game design

- Not purely an art nor an act of pure engineering
- Includes both creative and functional elements
- It must be aesthetically pleasing, but it also must work well and be enjoyable to play

The player-centric approach

- A philosophy of design in which the designer envisions a representative player of a game the designer wants to create
- The designer undertakes two key obligations to that player:
 - ▶ The duty to **entertain**
 - ▶ The duty to **empathise**

More on the player-centric approach

- Design rules on the player-centric approach:
 - ▶ “You are not your player”
 - ▶ “The player is not your opponent”

Stages of design process



Image source: Ernest Adams, Fundamental of Game Design, 2nd edition, New riders, 2010

Concept stage

- Define fundamental game concept
- Define game genre
- Define the target audience
- Determine the player's role in the game
- Concept should not be changed after this stage

Elaboration stage

- Add most of the design details and refine the decisions through prototyping and play testing
 - ▶ Define primary game mode
 - ▶ Design the core mechanics
 - ▶ Design the protagonist
 - ▶ Designing levels
 - ▶ Define the game world
 - ▶ Write the story
 - ▶ Build, test, and iterate

Tuning stage

- No new features may be added
- Make small adjustments to polish the game

To design a game...

- Design the core mechanics
- Design the user interface

Designing the core mechanics...

- Core mechanics consists of algorithms and data that precisely define the rules
- To design the core mechanics, you must document the different components that define how your game works. The key components that define how a game works include: **resources**, **entities**, **attributes** and **mechanics**

Resource

- A resource is a type of object or material that can be moved or exchanged within the game
- Handled as numeric quantities
- Examples: Weapons in an action game
- Core mechanics define how resources are used or traded and how they enter and leave the game

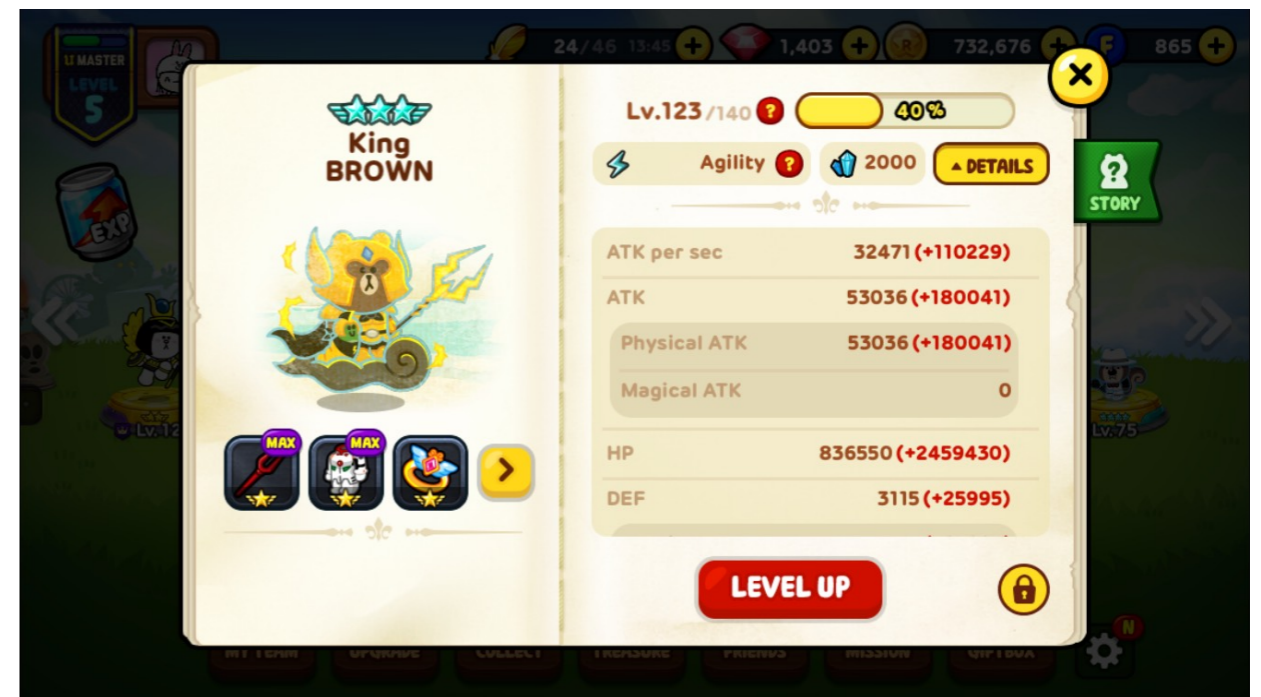
Entity and attribute

- An entity is an instance of a resource or the state of some elements of the game world
- Classified into simple entity and compound entity
- Simple entity: Defined by a single attribute
 - ▶ Example: Points scored in a basketball game
- Compound entity: Defined by multiple attributes
 - ▶ Example: A basketball in a basketball game has a number of attributes such as position, velocity and spin

Mechanics

- States the relationships among entities
- A global mechanic operates throughout the game
- Identifies the events and processes that take place among the resources and entities
- Tracks the conditions that trigger events and processes

Resource, entity, attribute and mechanics



Screen capture from LINE Rangers

The internal economy

- An **economy** is a system in which resources and entities are produced, consumed, and exchanged in quantifiable amounts
- If a resource or entity can come into the game world having not been there before, the mechanic by which it *arrives* is called a **source**
- A **drain** is a mechanic that determines the *consumption* of resources
- A **converter** is a mechanic that *turns* one or more resources into another type of resource
- A **trader** mechanic governs *trades* of goods, generally between the player and the game

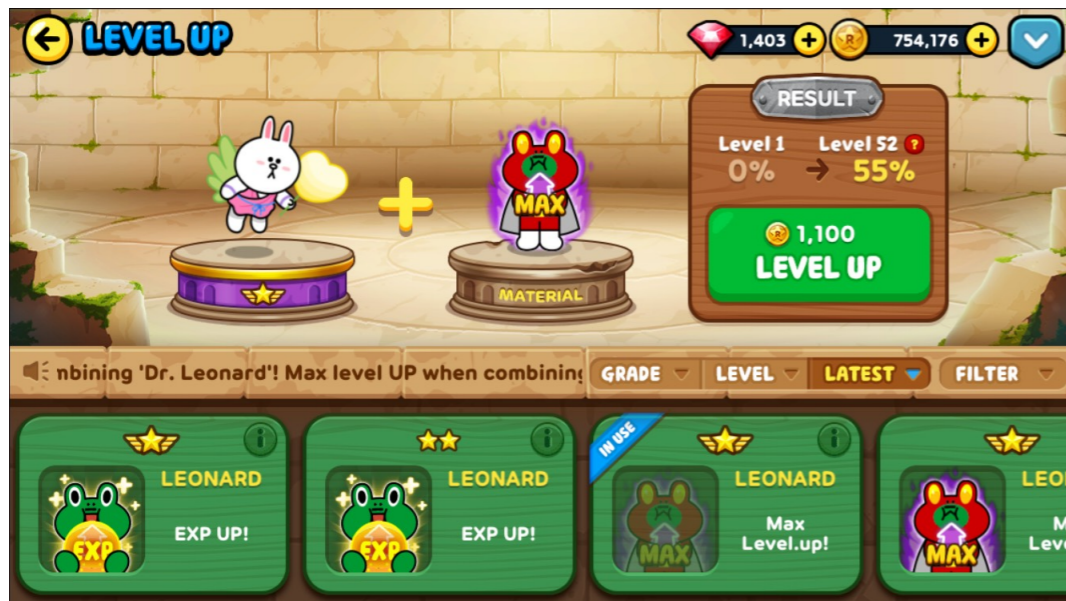
The internal economy



Source



Converter



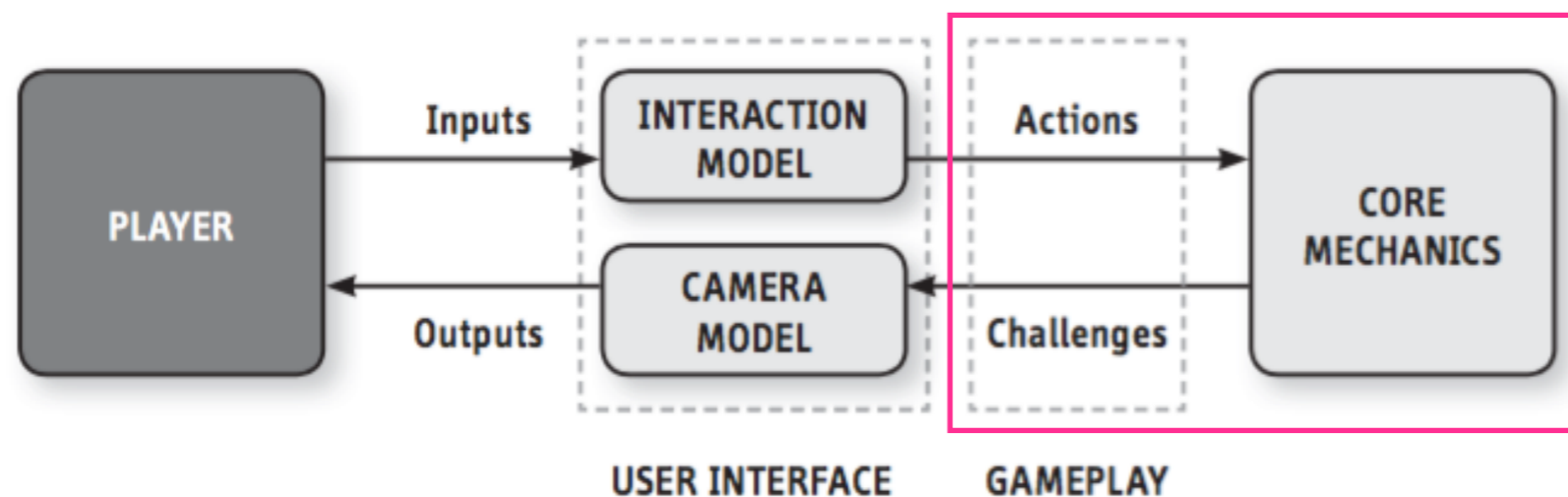
Drain



Trader

Core mechanics and gameplay

- Core mechanics presents challenges to the player and accepts actions from the player
- Player actions trigger mechanics



Designing the core mechanics...

- List out the sources, entities and attributes
- Add the mechanics: relationships, events, processes, and conditions
- Think about the challenges and actions

Designing the user interface...

- Focus on user experience
 - ▶ The experience must be entertaining
 - ▶ Inputs = control elements
 - ▶ Outputs = feedback elements: visual elements + audio elements

Presenting a game world

Pictures

Sound effects

Animations

Movies

Music

Dialogs

Text and subtitles



General principles of interface design

- Be consistent
- Give good feedback
- Avoid seizing control from the player
- Limit the number of steps required to take an action
- Permit easy reversal of actions
- Minimise physical stress
- Don't strain the player's short-term memory
- Group related screen-based controls and feedback mechanisms on the screen
- Provide shortcuts for experienced players

Player-centric interface design (1)

- Tell the player what he needs to know
 - ▶ Where am I?
 - ▶ What am I actually doing right now?
 - ▶ What challenges am I facing?
 - ▶ Did my action succeed or fail?
 - ▶ Do I have what I need to play successfully?
 - ▶ Am I in danger of losing a game?
 - ▶ Am I making progress?
 - ▶ What should I do next?
 - ▶ How did I do?

Player-centric interface design (2)

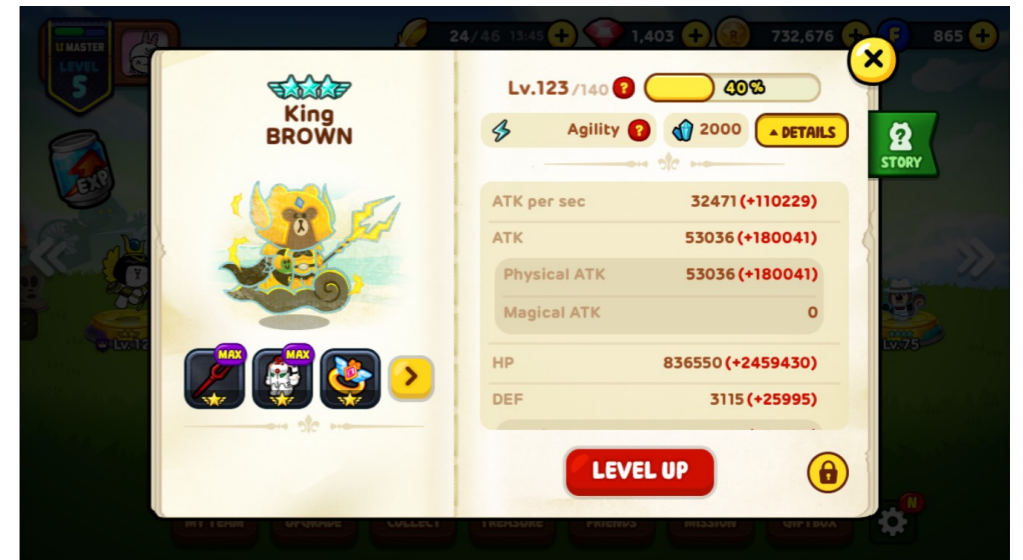
- Offer actions the player can perform
 - ▶ Move
 - ▶ Look around
 - ▶ Interact with non-player characters and objects
 - ▶ Construct and demolish objects
 - ▶ Conduct negotiations and financial transactions, and set numeric values
 - ▶ Give orders to units or characters
 - ▶ Customisation
 - ▶ Set game options
 - ▶ Pause, save, load, end the game

User interface design process

- Define the gameplay modes
- Define the camera model, interaction model, challenges and actions
- Think about the visual elements and controls that are needed for each mode
- Find a balance between the amount of screen space devoted to the main view and amount for feedback elements and onscreen controls

Visual elements

- Main view: windowed views, opaque overlay, semitransparent overlay
- Feedback elements:
 - ▶ Indicators inform about the status of a resource: digits, power bar, coloured lights, icons, text
 - ▶ Mini-maps
 - ▶ Colors
- Character portraits



Audio elements

- Sound effects
- Ambient sounds
- Music
- Dialog and voiceover narration
- Vibration

Other issues in design...

- Fairness
- Competition and cooperation
- Hiding the rules
- Setting the pace
- Artificial intelligence
- Storytelling
- Socialising

Fairness

- Players expect that the rules will guarantee that the game is **fair**
- Not an essential elements of a game, but a quality of good games

Competition and Cooperation

- When players **compete**, they try to accomplish mutually exclusive goals
- When players **cooperate**, they work together to accomplish goals that are the same or similar

Hiding the rules

- The game enforces the rules
- The player cannot change the rules
- Provide adequate clues for players to overcome a challenge

Setting the pace

- The player cannot affect the speed of the game unless the game need to wait for player input
- Pace of the events is determined by the game itself

Artificial intelligence

- Artificial intelligence can be used for
 - ▶ Strategy
 - ▶ Pathfinding
 - ▶ Simulating the behaviour of people and creatures
 - ▶ Natural language generation
 - ▶ Pattern recognition

Storytelling

- Some of the games incorporate some kind of story



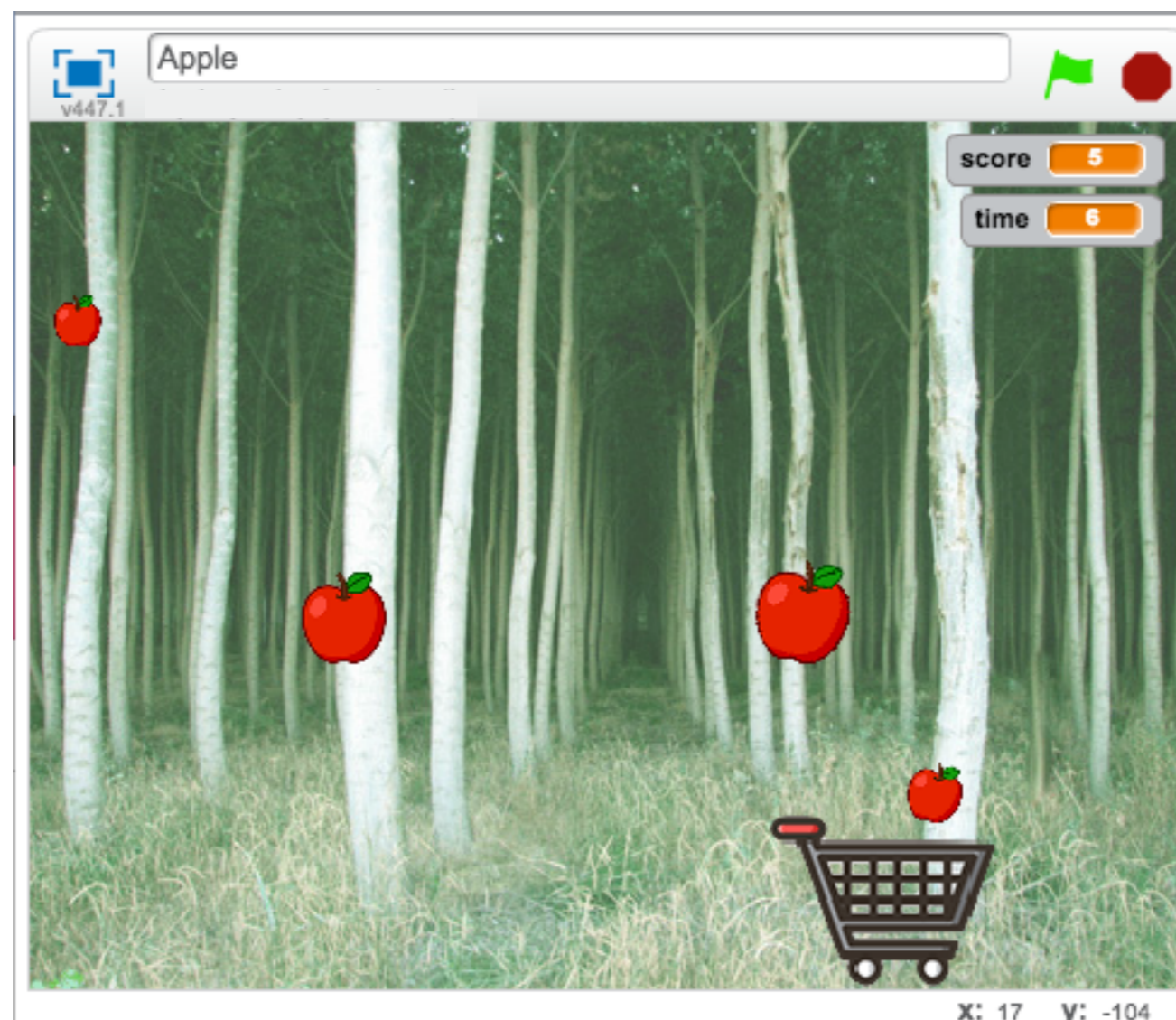
Socialising

- Make game playing as a social activity
- Consider designing a local multiplayer game, networked game, or interaction through social media



Introduction to game programming

Let's create a very simple game...



Let's do some simple design...

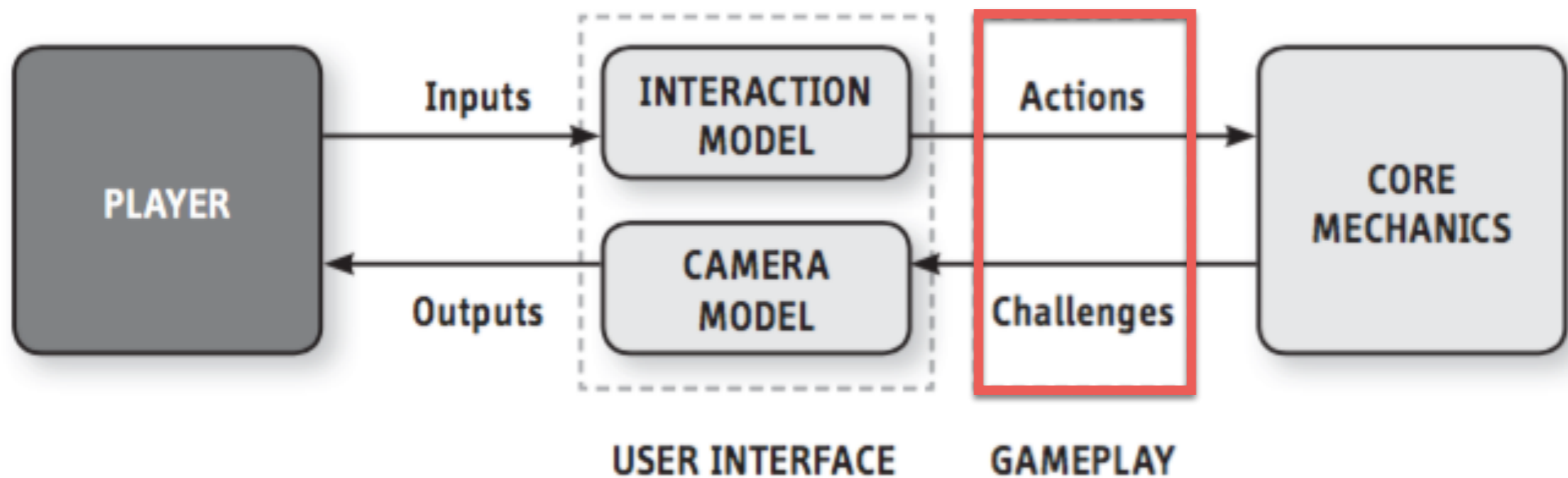


Image source: Ernest Adams, Fundamental of Game Design, 2nd edition, New riders, 2010

Design the gameplay

- Fundamental concept: Catch the apples
- Challenge: Maximize the number of apples caught by the cart within a time limit defined by the game
- Action: User moves the cart to catch the apples

Next...

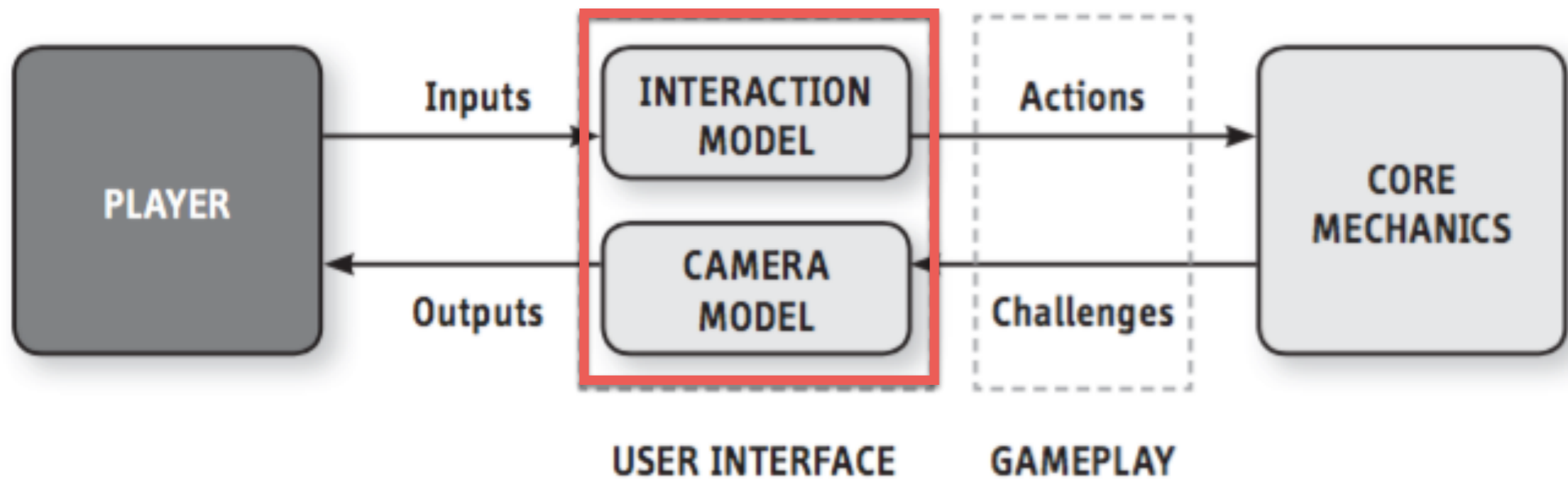


Image source: Ernest Adams, Fundamental of Game Design, 2nd edition, New riders, 2010

Design the user interface

- Interaction model = keyboard
 - Left arrow key and right arrow key to control the cart
- Camera model = static

Next...

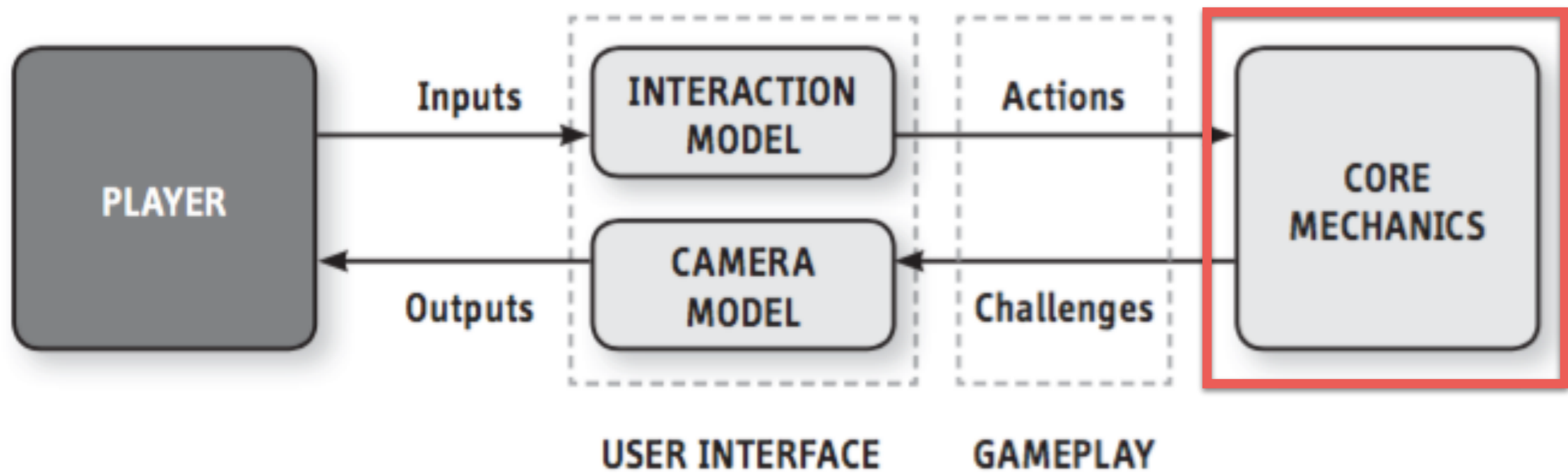
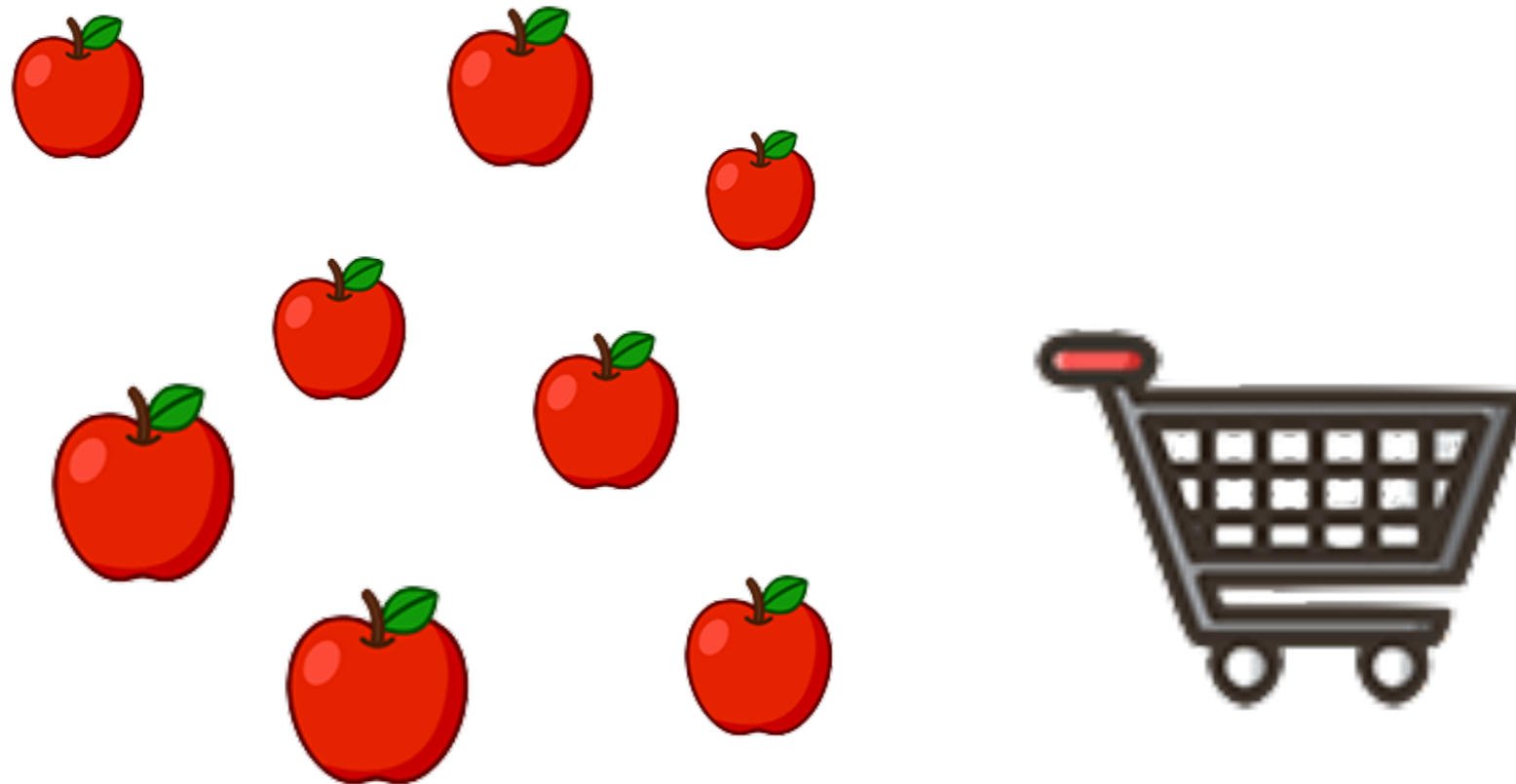


Image source: Ernest Adams, Fundamental of Game Design, 2nd edition, New riders, 2010

Core mechanics: Resources



Core mechanics: Entities and attributes



attribute	type	range
x position	integer	[-240, 240]
y position	integer	[-180, 180]
speed	integer	[-10, -2]

attribute	type	range
x position	integer	[-240, 240]
y position	integer	-110
speed	integer	±15

Core mechanics:

Mechanics of apple

- Apples will be generated automatically. It will fall from a random position at the top at a random speed
 - Clone the apple
 - Set a random *speed* value
 - Set a random *x position*
 - Set the *y position* of the apple above the top of the screen
 - Change the *y position* of the apple by *speed* continuously
 - Remove the apple when it moved out of the screen



Core mechanics:

Mechanics of cart

- The cart will move left or right at a fixed *speed*
- The direction of move is specified by the user
- Left arrow key = move left
= Change *x position* by negative *speed*
- Right arrow key = move right
= Change *x position* by positive *speed*



Core mechanics:

Mechanics of score and time

- To include challenge and give feedback:
 - Time: Player plays each game within a limited *time*
 - Score: Maximizes the *score*

Core mechanics: Mechanics of time

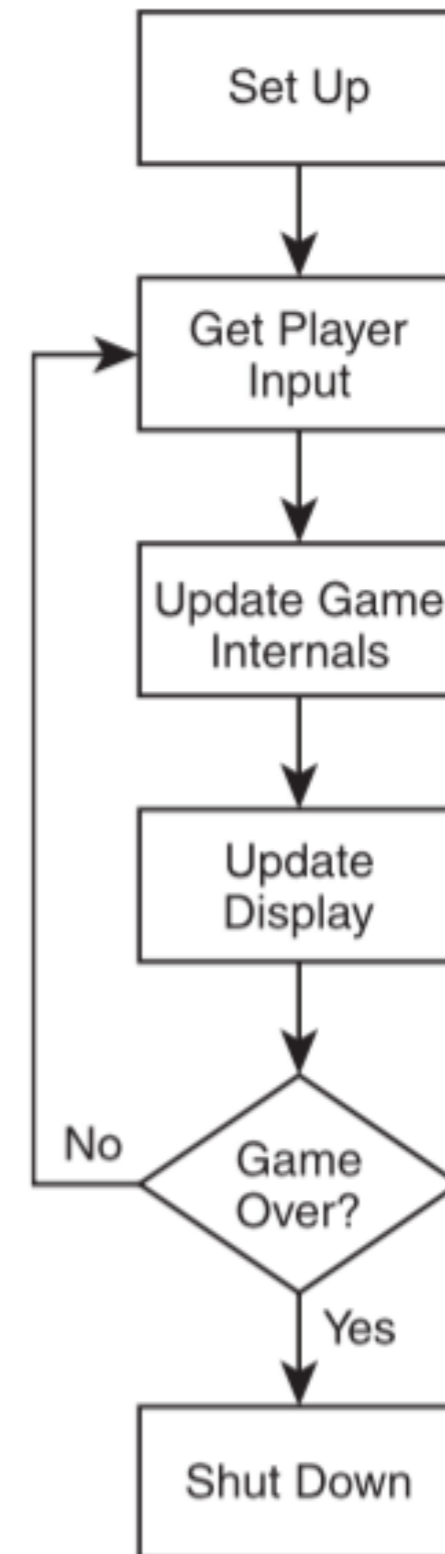
- When the game starts, set time counter to a predefined *time* limit (e.g., 30 seconds)
- Decrease the value of *time* every second by 1
- When *time* = 0, game ends

Core mechanics: Mechanics of score

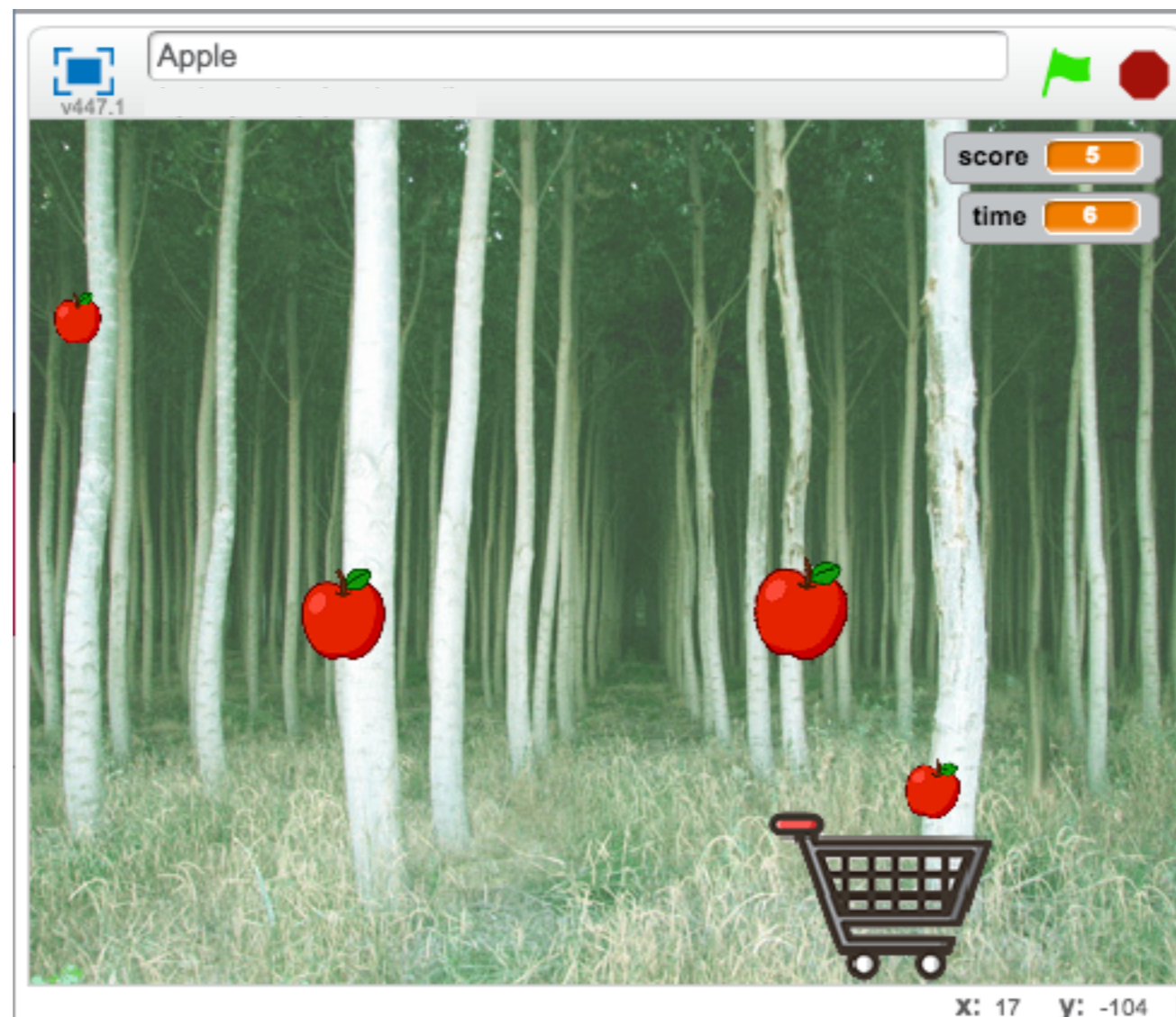
- When an apple touches the cart, increase the *score* by 1
- When an apple leaves the screen without caught by the cart, decrease the *score* by 1

Game loop

- The game loop is a generalized representation of the flow of events in a game



Put it all together...



Gamification

What is gamification?

- Gamification — the use of game design elements in non-game contexts
- Game design can be a valuable approach for making non-game products, services, or applications, more enjoyable, motivating, and/or engaging to use
- Used in different application domains include education, business, environmental protection, etc

References

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- Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. From game design elements to gamefulness: defining "gamification". In Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments (MindTrek '11). ACM, New York, NY, USA, 9-15

**GAME
OVER**